POSTER SESSION

DERMAL EXPOSURE OF MIXERS/LOADERS, APPLICATORS AND HARVESTERS TO CAPTAN, CHLOROTHALONIL AND FOLPET

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ABSTRACT

Dermal exposure estimates are essential for risk assessments of pesticides. Passive dosimeters and less frequently biological monitoring of exposure have been used for dermal exposure studies. A combination of passive dosimeters were used for assessment of mixers/loaders, applicators and harvesters exposure to captan, folpet and chlorothalonil.

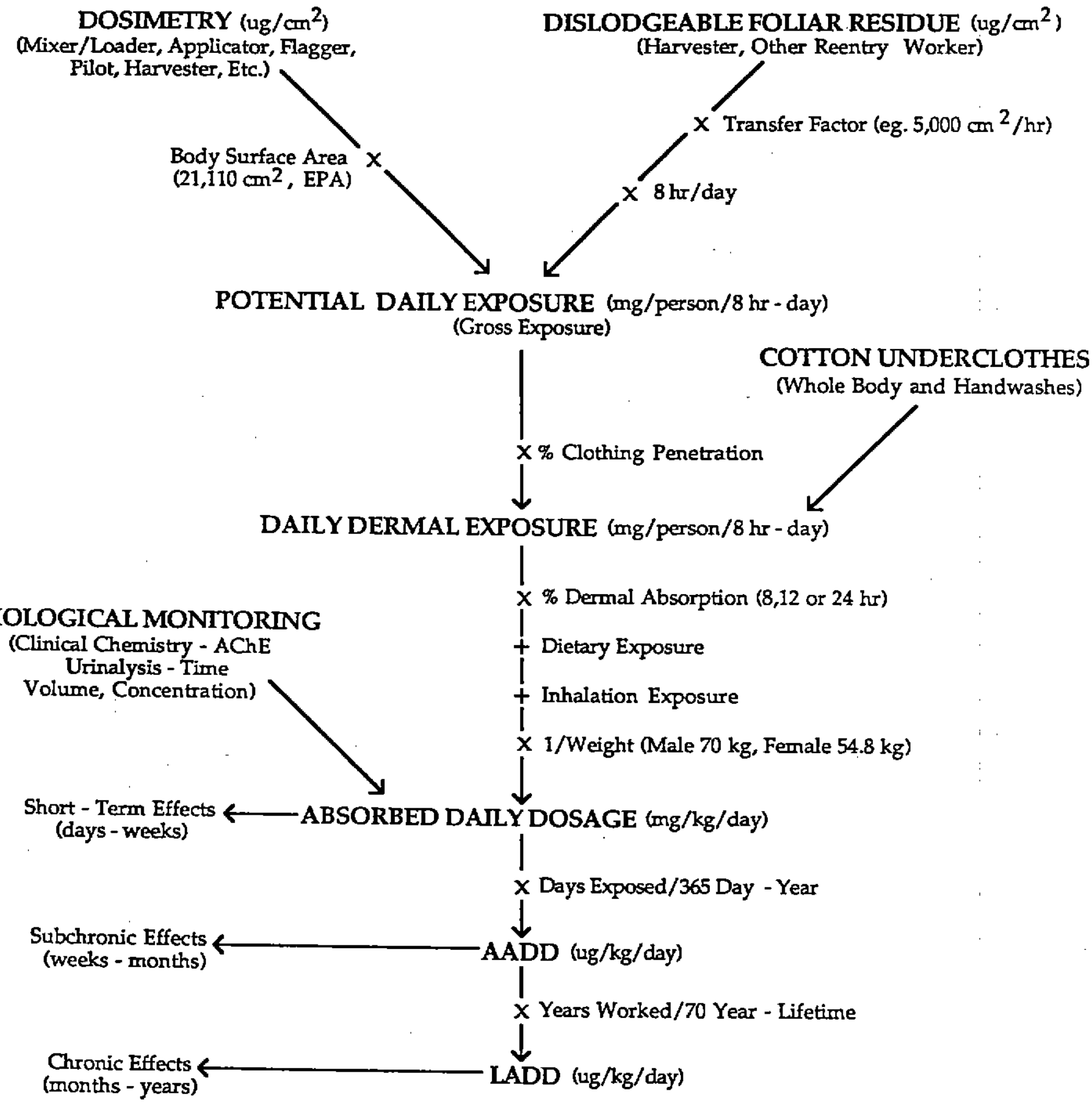
Daily dermal exposure of pole tomato harvesters was 4.8 - 21.2 mg (dermal transfer factor, DTF=316 - 1400 cm^2/hr) depending on types of protective clothing. Without gloves and combining exposure from overshirt and dosimeter, a worker received a daily dermal exposure of 24 mg (DTF=1580 cm^2/hr). Clothing penetration of chlorothalonil in this study was 31%. Daily dermal exposure of mixer/loader/applicator to captan applied to strawberries and grapes were 4.6 and 14.8 mg, respectively. Lettuce cutters and packers had lower daily dermal exposure of 4.7 and 2.4 mg (DTF=890 and 455 cm^2/hr), respectively. Plum thinning workers without wearing gloves received a daily dermal exposure of 6.15 mg with a high apparent DTF of 54,900 cm^2/hr.

INTRODUCTION

Determination of dermal exposure of agricultural workers to pesticides is an important and essential step in the risk assessment process. The exposure of workers including mixers/loaders, applicators and harvesters may be evaluated by several methods as shown in the "Pesticide Exposure Assessment" diagram (FIGURE I). Passive dosimeters such as gauze or cloth patches have been generally used to assess dermal exposure. Whole body 100% cotton dosimeters were introduced recently by the Worker Health and Safety Branch, California Department of Food and Agriculture as an alternative to extrapolation of dermal dosage from patches.

Passive dosimeters were employed to evaluate the dermal exposure to captan, folpet and chlorothalonil. Biological monitoring was used to estimate the exposure of workers to captan. Dermal transfer factors were estimated from total dermal exposure and dislodgeable foliar residues.

PESTICIDE EXPOSURE ASSESSMENT



NOTES:
AADD Annual Average Daily Dosage
LADD Lifetime Average Daily Dosage

Thongsinthusak and Krieger, 1989
Worker Health and Safety Branch
California Department of Food and Agriculture

METHODS

A. Dermal exposure monitors included:

1. 100% cotton long-sleeved T-shirt worn under normal work clothing or overshirt

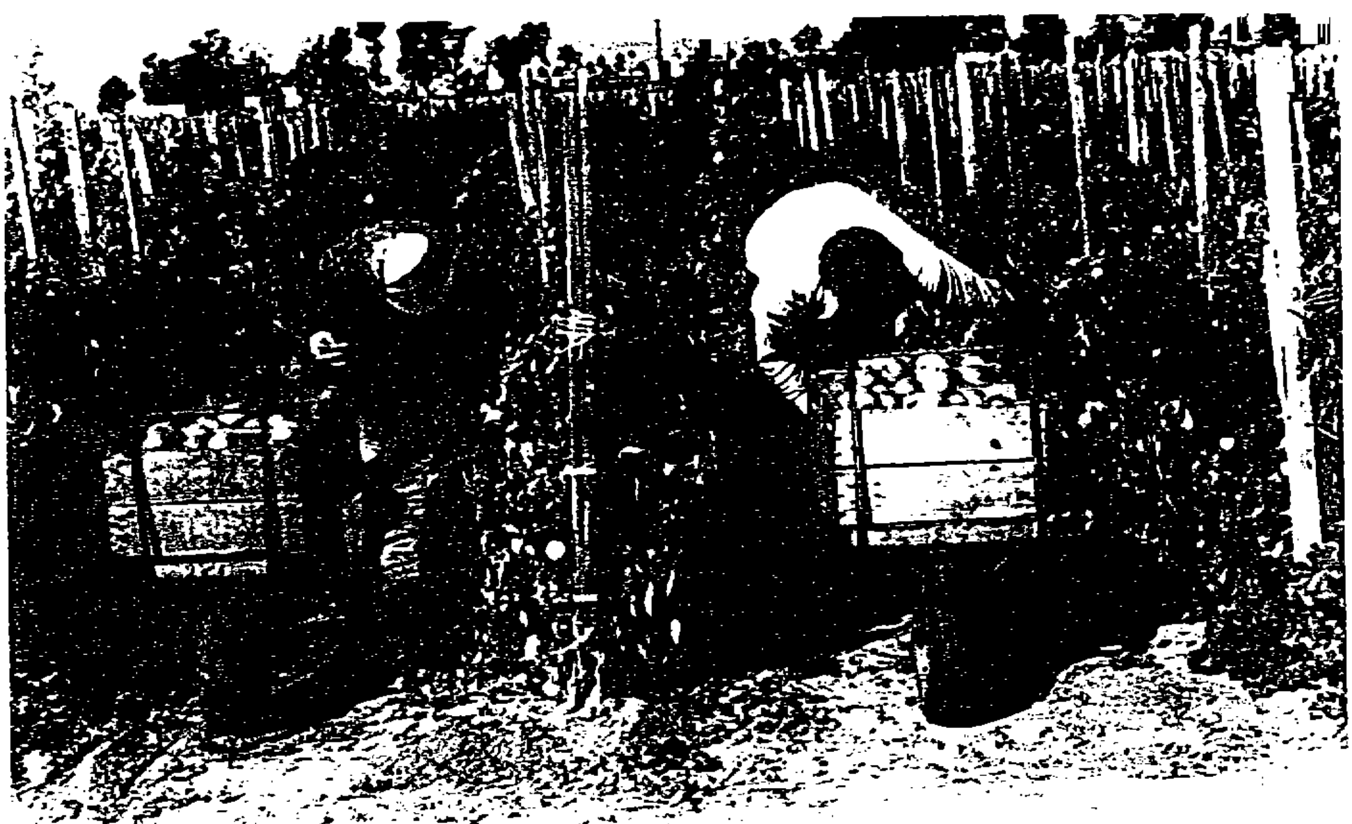
2. Knee length cotton socks

3. 10-layer gauze patches backed by aluminum foil and in paper case (modified Mobay holder)

4. Hand and face wiping with Chubbs^{R} brand towelettes. Handwashing was done in 0.1% Sur-Ten solution.

B. Biological monitoring: complete urine samples were collected for three days following the first day of exposure to captan.

C. Dislodgeable foliar residues: leaf discs were collected randomly using a Birkestrand leaf-puncher (2.54 cm) fitted with a 4 oz glass jar. Discs were stored on ice and later surface extracted (3x20 min) with 3x50 mL 0.02% Sur-Ten solution. Pesticides were extracted with ethyl acetate for analysis.



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Pole Tomato Harvester and Leaf Sampling Method

RESULTS

TABLE I DERMAL CHLOROTHALONIL EXPOSURE OF PROTECTED AND UNPROTECTED POLE TOMATO HARVESTORS[a]

Glove type	Shirt type	Mean Dermal Exposure (mg/8h-d) hands[b]	arms[c]	torso[d]	front thighs[e]	Harvester Exposure Total (mg)	Dermal Transfer Factor (cm^2/h)[f]
Latex	LS(N) n=6	0.2	3.7	0.4	0.5	4.8±2.6	316
	LS(U) n=2	0.2	4.1	0.3	0.4	5.0±4.0	329
Nylon Knitted (new)	LS(N) n=27	1.3	6.3	0.4	0.9	8.9±4.4	586
	LS(U) n=2	1.8	6.4	0.2	0.5	8.9±1.0	586
Nylon Knitted (used)	LS(N) n=1	2.5	10.7	0.5	1.1	14.8	974
	LS(U) n=9	1.6	4.8	0.2	0.4	7.0±3.1	461
	SS(U) n=4	4.4	15.7	0.3	0.8	21.2±6.6	1400
No Gloves	LS(N) n=3	14.1	7.7	0.6	1.0	23.4±11.2	1540
	LS(U) n=7	15.4	6.8	0.4	0.9	23.5±13.8	1540
	LS+D n=10	5.0	8.3	0.[illegible]	0.6	24 0±14.7	1580

D = 100% cotton long-sleeved T-shirt dosimeter
LS = long-sleeved shirt
SS = short-sleeved shirt
LS+D = composite samples; both LS and D were analyzed for chlorothalonil residue
N = new cleaned shirt (laundered)
U = harvester's work clothing that had been previously used

a Application rate by aircraft = 2.25 lb ai/A; harvesters entered field 3,6,7 days post application.
b Handwashes were done using 0.1% Sur-Ten solution.
c Dermal exposures were from sleeves of 100% cotton long-sleeved T-shirt dosimeters.
d Dermal exposures were from torso of 100% cotton long-sleeved T-shirt dosimeters.
e Dermal exposures extrapolated from dermal dosimeters (gauze and foil layers).
f Dermal transfer factor $(cm^2/h) = \frac{\text{Total dermal Exposure (ug/h)}}{\text{Dislodgeable foliar residue } (ug/cm^2)}$

Dislodgeable foliar residue = 1.9 ± 0.8 ug/cm^2

TABLE II CLOTHING PENETRATION OF CHLOROTHALONIL

	Chlorothalonil Exposure (mg/8h-d)					
	Overshirt[a]			Cotton Undershirt[b]		
	Torso	Arms	Total	Torso	Arms	Total
Mean (n=11)	4.2	15.2	19.4	0.3	8.5	8.8
Range	1.7-8.7	10.9-19.8	12.6-28.5	0.2-0.6	2.4-12.8	2.6-13.4

$$\% \text{ clothing penetration of captan} = \frac{100 \times 8.8}{(19.4 + 8.8)} = 31\%$$

% clothing penetration was estimated to be approximately 10% by:

1. Davies et al. J. Occup. Med. 24:264-268 (1982).
2. Leavitt et al. Arch. Environ. Contam. Toxicol. 11:57-62 (1982).
3. Maddy et al. Symposium on Biological Monitoring of Workers Exposed to captan pesticides. ACS Symposium, New Orleans, LA (1987).

a Long-sleeved shirt
b 100% cotton long-sleeved T-shirt worn under overshirt

TABLE III EXPOSURE OF MIXER/LOADER/APPLICATOR TO CAPTAN

Crop	Mean Daily Dermal Exposure (mg/8h-d)				Inhalation[g] (mg/8h-d)	Total (mg/8h-d)
	Hands	**Arms[e]**	**Torso[e]**	**Thighs & Legs**		
Strawberries[a]	0.6[c]	1.9	1.1	0.9[e]	0.1	4.6
Grapes[b]	1.9[d]	0.5	0.7	11.6[f]	0.1	14.8

Glove protection factor = 89-94%

a Application Rate: 2 lb ai/A
b Application Rate: 2.5 lb ai/A
c Handwashing using 0.1% Sur-Ten solution
d Handwiping using Chubbs[R] brand towelettes
e Dosimeter: 100% cotton long-sleeved T-shirt (section into arms and torso)
f Dosimeters: Gauze patches and socks
g Determined using air sampling pump (MSA Fixt-Flo Model One) connected to XAD-2 resin tube

TABLE IV DERMAL EXPOSURE OF LETTUCE HARVESTERS TO FOLPET*

Work Task	Mean Daily Dermal Exposure (mg/8h-d)	Mean Dermal Transfer Factor (cm^2/hr)
Cutter (n=5)	4.7 ± 4.0	890
Packer (n=6)	2.4 ± 1.6	455
Driver (n=1)	0.6	112

* Dosimeters: Stomach gauze patch under shirt, knee length socks, bilayer thigh patches.

Two-arm washes (elbow to hand) represent hand and arm exposure.

Application rate: 1 lb ai/A; Harvesting was 11 days post application Dislodgeable foliar residue = 0.66 ± 0.35 ug/cm^2.

TABLE V POTENTIAL DERMAL CAPTAN EXPOSURE DURING PLUM THINNING

	Dermal Exposure (mg/8 h-d)					
	Lower[a]			Hand[c]		Total
	legs	arms[b]	torso[b]	captan	captan equiv.	exposure (mg)
Mean +SD	0.07+0.03	2.74+1.4	1.74+0.97	0.59+0.23	1.01+0.29	6.15+2.47

Average foliar dislodgeable residue = 0.014+0.017 ug/cm^2

Apparent transfer factor = $\frac{6.15\ mg}{8\ h} \times \frac{cm2}{0.014\ ug} = 54{,}900\ cm^2/h$

Plum thinning is a high contact work task performed in April and May in California

a Knee length cotton socks.

b 100% cotton long-sleeved T-shirt worn under overshirt.

c No gloves; hand washing using 0.1% Sur-Ten solution. Exposure comprised of captan and THPI (captan equivalents).

CONCLUSION

Cotton long-sleeved T-shirts and knee length cotton socks have been used effectively as passive dosimeters. The results will apparently give a more representative dermal exposure estimate than from extrapolation of gauze patch dosimeters in which a uniform exposure was assumed. Different field activities will give different dermal transfer factors depending on how frequently workers come in contact with plant surfaces. High contact activities during work will yield a high transfer factor, consequently, high dermal exposure.